TETA TO-0010
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TEST EFFECTIVENESS TREND OBSERVATION

Distribution of the Causes of Anomalies Occurring During Thermal-Vacuum Tests

CONCLUSION:

For the Voyager and Galileo pro ects, design defects were the primary cause of anomalies occurring during thermal-vacuum tests. Consequently, it may be more cost effective to implement more design analyses and reviews early rather than incur the cost of redesign and rework subsequent to the initial testing.

DISCUSSION:

Previously a survey was made of the number of problem/failures or anomalies occurring during the environmental testing of the Voyager and Galileo flight hardware (TETA TO-0003). The results of that analysis concluded that the most effective environmental test for discovering flight hardware problems is thermal/vacuum testing. About twice as many anomalies were uncovered during the thermal/vacuum testing as those uncovered during dynamic testing, the second most effective test. Thermal/ vacuum testing is the dominant environmental test for uncovering flight hardware defects although the trend is for EMC testing to increase in significance as the electronic functional elements have decreased in size (TETA TO-0005). Since thermal/vacuum testing is effective in uncovering defects, the problem/failure reports (PFRs) were reviewed to examine the distribution of defect categories resulting during thermal/vacuum testing.

Three categories were considered as the source of all flight hardware defects:

(1) design

(2) workmanship and manufacturing

(3) parts and material failures.

Although other sub-categories could be defined, these three categories broadly contain the cause of all screened defects.

The PFRs written during assembly-level thermal/vacuum testing or as a result of the assembly-level thermal/vacuum testing for Voyager and Galileo were classified into one of these categories. The results are provided in the following table.

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Assembly-Level Thermal/Vacuum Test Causes

Cause	Voyager		Galileo		Total	
	Number	%	Number	%	Number	%
Design	16	43	15	44	31	43.6
Workmanship and Manufacturing	10	27	9	26.5	19	26.8
Parts and Materials	11	30	10	29.5	21	29.6
Total	37	100	34	100	71	100

The above table shows that the 43.7 percent of the total defects occurring during the Voyager and Galileo thermal/vacuum tests were design related, while 29.6 percent were parts and materials related and 26.8 percent were workmanship and manufacturing related. Thus, the ma or cause of anomalies during thermal/vacuum test is design defects, producing about one and one-half times as many anomalies as either workmanship and manufacturing causes or parts and materials causes. The latter two causes produced nearly equal number of anomalies.

The percentage of anomalies related to design defects was essentially the same during the Galileo tests (44 percent) as those screened during the Voyager tests (43 percent). In addition, the table shows that the distributions of screened defects for Voyager, Galileo and the total are essentially the same. The similarity probably results from the fact that the two pro ect were implemented in the same mode, used the same class of electronic parts, were fabricated using similar processes, and was environmentally tested to the same standards.

This result points up the importance of design analyses, reliability analyses, the analysis reviews, and design reviews in the overall design process. Clearly a trade-off exists between implementing activities to uncover design defects prior to testing and using testing to uncover design defects. The latter can be expensive both from the standpoint of dollar cost and schedule cost. The relative importance depends on the quantity of redesign required and the quantity of retest required.

A future trend report will follow-up on these issues and extend them to other test environments, i.e. dynamics and EMC.